PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 5 : E04C 3/30 — A1

(11) International Publication Number: WO 91/17328

(43) International Publication Date: 14 November 1991 (14.11.91)

(21) International Application Number: PCT/US91/02944

(22) International Filing Date: 29 April 1991 (29.04.91)

(30) Priority data:
518,554 — 3 May 1990 (03.05.90) — US
674,549 — 22 March 1991 (22.03.91) — US

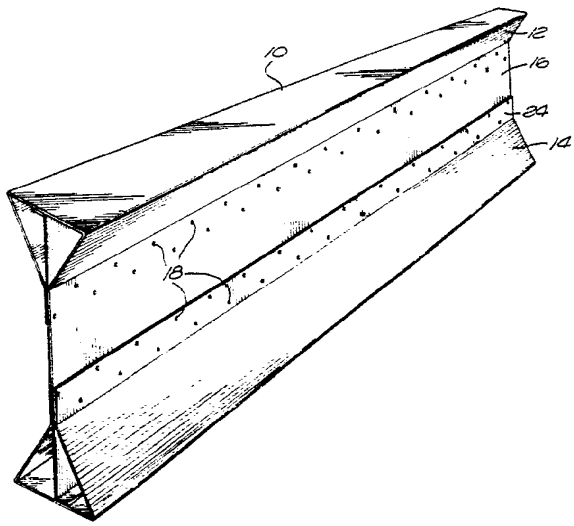
(71)(72) Applicant and Inventor: NAHON, Ram [IL/US]; 1320 Poinsettia Place, Apartment #7, Los Angeles, CA 90046 (US).

(74) Agents: HOOVER, George, W. et al.; Blakely, Sokoloff, Taylor & Zafman, 12400 Wilshire Boulevard, 7th Floor, Los Angeles, CA 90025 (US).

(81) Designated States: AT, AT (European patent), AU, BB, BE (European patent), BF (OAPI patent), BG, BJ (OAPI patent), BR, CA, CF (OAPI patent), CG (OAPI patent), CH, CH (European patent), CM (OAPI patent), DE, DE (European patent), DK, DK (European patent), ES, ES (European patent), FI, FR (European patent), GA (OAPI patent), GB, GB (European patent), GR (European patent), HU, IT (European patent), JP, KP, KR, LK, LU, LU (European patent), MC, MG, ML (OAPI patent), MR (OAPI patent), MW, NL, NL (European patent), NO, PL, RO, SD, SE, SE (European patent), SN (OAPI patent), SU, TD (OAPI patent), TG (OAPI patent).

Published
With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: STRUCTURAL BEAM



(57) Abstract

A fabricated structural beam (10) comprises at least one longitudinally folded member having a web portion (16) and a head portion (12, 14). In different embodiments, a plurality of folded members may be interleaved with one another to provide configurations of varying load carrying capabilities. In all cases, the folded head portion (12, 14) is made rigid by forming it into a tube that is closed on all sides. This is accomplished by fastening the folded material upon itself in the web portion (16).

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	**ES**	Spain	**MG**	Madagascar
AU	Australia	**FI**	Finland	**ML**	Mali
BB	Barbados	**FR**	France	**MN**	Mongolia
BE	Belgium	**GA**	Gabon	**MR**	Mauritania
BF	Burkina Faso	**GB**	United Kingdom	**MW**	Malawi
BG	Bulgaria	**GN**	Guinea	**NL**	Netherlands
BJ	Benin	**GR**	Greece	**NO**	Norway
BR	Brazil	**HU**	Hungary	**PL**	Poland
CA	Canada	**IT**	Italy	**RO**	Romania
CF	Central African Republic	**JP**	Japan	**SD**	Sudan
CG	Congo	**KP**	Democratic People's Republic of Korea	**SE**	Sweden
CH	Switzerland			**SN**	Senegal
CI	Côte d'Ivoire	**KR**	Republic of Korea	**SU**	Soviet Union
CM	Cameroon	**LI**	Liechtenstein	**TD**	Chad
CS	Czechoslovakia	**LK**	Sri Lanka	**TG**	Togo
DE	Germany	**LU**	Luxembourg	**US**	United States of America
DK	Denmark	**MC**	Monaco		

STRUCTURAL BEAM

RELATED APPLICATION

This is a continuation-in-part of serial no. 07/518,554 filed May 3, 1990.

FIELD OF THE INVENTION

This invention relates to the field of structural building materials, and more particularly to a fabricated structural beam.

BACKGROUND OF THE INVENTION

A variety of types of structural beams are used in non-residential construction. Some examples include fabricated wooden girders, laminated wood beams and reinforced concrete beams. By far, the most commonly used material is structural steel of various cross sections, such as "I"-section, "H"-section, "C"-section, "Z"-section and channel section. These structural steel shapes are most commonly manufactured by hot or cold rolling processes and generally provide a relatively heavy beam for a given load carrying capacity.

Structural sections fabricated from sheet steel are used in some construction applications. For example, it is now a common practice to utilize fabricated steel studs, particularly in non-residential construction. These are generally made from galvanized steel sheet, cold-rolled into a "C"-section or channel section. Furthermore, corrugated or fluted steel sheets are widely used in flooring and roofing applications.

Certain other fabricated structural shapes are known in the prior art. For example, Figure 1 illustrates a prior art structural shape fabricated from sheet steel. Beam 1 comprises a web portion 2 and opposing head portions 3 and 4. As can be clearly seen in the illustration, beam 1 can be easily fabricated from a single flat sheet of steel by rolling or otherwise folding the sheet longitudinally. It should be noted that edges 5 and 6 of the sheet are folded back towards web portion 2, but are not fastened or otherwise secured thereto. A prior art beam such as beam 1 has a very limited load bearing capability.

It is one of the objects of the present invention to provide a fabricated structural beam that has a load carrying capability comparable to that of conventional hot or cold rolled structural steel sections, but which is light in weight compared to a conventional section of equal load carrying capability.

SUMMARY OF THE INVENTION

The fabricated structural beam of the present invention comprises at least one longitudinally folded member having a web portion and a head portion. In different embodiments, a plurality of folded members may be interleaved with one another to provide configurations with varying load carrying capabilities. In all cases, the folded head portion is made rigid by forming it into a tube that is closed on all sides. This is accomplished by fastening the folded material upon itself in the web portion. Further embodiments of the invention fabricate the head portions of the beam from individual longitudinal members.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a cross sectional view of a prior art fabricated structural beam.

Figure 2 is perspective view of a preferred embodiment of a fabricated structural beam according to the present invention.

Figure 3 is a cross sectional view of the beam shown in Figure 2.

Figures 4a, b illustrate the individual folded members used to construct the beam illustrated in Figures 2 and 3.

Figure 5 illustrates another embodiment of the present invention.

Figure 6 illustrates a modification of the embodiment shown in Figure 5.

Figure 7 illustrates yet another embodiment of the present invention.

Figure 8 illustrates a modification of the embodiment shown in Figure 7.

Figure 9 illustrates still another embodiment of the present invention.

Figure 10 illustrates yet a further embodiment of the present

invention.

Figure 11 illustrates an additional embodiment of the present invention.

Figures 12a-12e illustrate variations on an embodiment of the present invention having fabricated head structures.

DETAILED DESCRIPTION OF THE INVENTION

In the following description, for purposes of explanation and not limitation, specific numbers, dimensions, materials, etc. are set forth in order to provide a thorough understanding of the present invention. However, it will be apparent to one skilled in the art that the present invention may be practiced in other embodiments that depart from these specific details.

Referring first to Figures 2 and 3, a preferred embodiment of the present invention will be described. Beam 10 comprises a pair of triangularly shaped head portions 12 and 14 joined together by web portion 16. In overall configuration, beam 10 is thus similar to a conventional "I" beam. However, unlike a conventional structural beam, beam 10 is fabricated from relatively thin gauge sheet material. In most applications, beam 10 will be built up from cold rolled sheet steel. However, it is to be understood that the present invention is not limited to such a choice of material, but may be constructed from any suitable malleable sheet material. In particular, certain applications may recommend the use of aluminum or even a plastic.

The construction of beam 10 can best be understood with reference to Figures 4a and 4b which illustrate the individual members 20 and 30 that are interleaved to form beam 10. Member 20 is folded longitudinally and comprises a web portion 22, triangular head portion 14, web flange 24 and tail flange 26. In the illustrated embodiment, member 30 is identical to member 20, but need not be so. Members 20 and 30 are interleaved

such that web portion 22 of member 20 extends between web portion 32 and web flange 34 of member 30. Likewise, web portion 32 of member 30 extends between web portion 22 and web flange 24 of member 20. Tail flange 26 of member 20 abuts wall 13 of triangular head portion 12. Likewise, tail flange 36 of member 30 abuts wall 15 of triangular head portion 14.

It is preferable that the cross-section of head portions 12 and 14 be substantially equilateral triangles. However, the invention is not limited in this regard.

Members 20 and 30 are secured to one another by fastening means 18. Fastening means 18 may comprise conventional mechanical fasteners, such as rivets or screws. Fastening means 18 may also comprise other conventional fastening means, such as spot welding or adhesives. The preferred embodiment utilizes a fastening technique sold under the trademark TOX by Pressotechnik, GMBH and its licensees. This technique employs a stamp and die to join together two or more thicknesses of material in a cold extrusion forming process. The TOX process is particularly advantageous for use with the present invention since it is fast, does not employ consumable fasteners and does not rupture anti-corrosion coatings.

Web portion 16 of fabricated beam 10 comprises two thicknesses of material. For applications requiring a greater web thickness, either or both of web flanges 24 and 34 may be extended such that web portion 16 comprises three or four thicknesses of material.

Beams of the present invention, such as beam 10, may be conveniently fabricated by a continuous process wherein coils of sheet steel are fed through a suitable arrangement of rollers to impart the desired longitudinal folds and simultaneously interleave the members. The fabricated beam then passes through an array of mating stamp and die sets to fasten the members together at suitable intervals. The length of the completed beam is not inherently limited by such a process, and thus beams of any practical length can be readily manufactured. Moreover, the arrangement of rollers can be relatively easily altered to produce beams of differing transverse dimensions. The manufacturing process also easily accommodates sheet materials of different thicknesses so that the load capacity of the manufactured beam may be selected for each lot produced. For relatively large construction projects, suitable equipment may be located at the job site to produce beams according to the present invention in a manner somewhat analogous to that used for on-site fabrication of residential gutters.

Referring next to Figure 5, another embodiment of the present invention is illustrated. Here, beam 40 comprises members 42 and 44. These members may be fastened together at locations 45, 46 and 47 as shown in Figure 5; however, it is preferable to insert a third member 50 between members 42 and 44 as shown in Figure 6. Insert 50 includes tail flanges 52 and 54 that abut against the respective triangular head portions of members 42 and 44. Members 42, 44 and 50 are fastened together by fastening means 18 as described above. The resulting structure of beam 40 is quite similar to that of beam 10 as illustrated in Figure 3, except that

the web portion comprises three thicknesses of material. This embodiment has the particular advantage that member 50 may be made of a heavier gauge material than members 42 and 44, thereby imparting additional strength to beam 40 without necessarily increasing the thickness of material in the head portions of the beam. It should be noted that member 50 may comprise a conventional "I" beam or other conventional steel section where substantial reinforcement is desired. Member 50 need not be inserted over the entire span of beam 40, but may be inserted only in certain longitudinal regions requiring additional reinforcement.

Still another embodiment of the present invention is illustrated in Figure 7. Beam 60 comprises a single longitudinally folded member having parallel web portions 62 and 64, head portion 66 and opposing tail flanges 68 and 70. This embodiment can be utilized as illustrated in Figure 7 by fastening web portion 62 and 64 together at locations 72 and 74. However, it is preferable to add a second longitudinal member 76 as shown in Figure 8. Member 76 includes tail flange 78 that abuts head portion 66. As with the other embodiments thus far described, web portion 62 and 64 and member 76 are secured by fastening means 18. As with the embodiment illustrated in Figure 6, member 76 may be of the same or a heavier gauge than the remainder of the beam.

Referring now to Figure 9, a modification of the embodiment illustrated in Figures 2 and 3 is shown. In this embodiment, members 20' and 30' are essentially identical to members 20 and 30 previously described except for corrugations 80 and 82. These corrugations are added to provide additional stiffness in beam 10'.

In a similar manner, Figure 10 illustrates a further modification of beam 10 as shown in Figures 2 and 3. Beam 10" includes embossed ribs or corrugations 86 on the sloping walls of head portions 12" and 14". It will be understood that other patterns of corrugations and other means of reinforcement may be incorporated with any of the embodiments described herein.

With reference now to Figure 11, yet another embodiment of the present invention is shown. Beam 100 is constructed in a manner essentially similar to the embodiments described above. However, this design offers significant advantages as will be described below.

Beam 100 comprises web member 102, which includes tail flanges 104 at each end. Beam 100 also comprises a pair of identical head members 106. Each of head members 106 is folded approximately in the shape of an equilateral triangle having sides 107, 108 and 109. Side 109 terminates with web flange 110 and side 107 terminates with web flange 111 in like manner. Flanges 104 of web member 102 are secured to sides 108 of head members 106 by means of fasteners 18. Likewise, tail flanges 104 of web member 102 are secured to sides 108 of head members 106 by means of fasteners 18. As discussed in connection with the previously described embodiments, fasteners 18 may be any suitable form of fastener. However, in this embodiment, the TOX fastening system is not preferred because of the difficulty of positioning a dye within the triangular head members. More suitable fastening means for this embodiment are rivets or spot welding.

In beam 100, shear and bearing loads are carried by sides 107 and 109 of head members 106 and also by web member 102. By fastening the web member flanges 104 to head member sides 108, greater flexural strength is achieved in comparison to the beams described above. Moreover, web member 102 of this embodiment increases the buckling strength of the head members. The thickness of web element 102 may be selected to achieve any desired beam strength. It is to be noted that this selection may be independent of the selected thickness of head members 106, thereby allowing the structural characteristics of beam 100 to be optimized for particular applications.

Figures 12a-12e illustrate further variations of structural beams within the scope of this invention. Referring first to Figure 12a, the basic characteristics of this design will be described with equal applicability to the variations shown in Figures 12b-12e. Beam 120 comprises a pair of identical web members 122. Each of web members 122 has a center portion 124, outwardly angled intermediate portions 126, and flange portions 128. Web members 122 are attached to one another at their respective center portions 124 by means of fasteners 18.

Beam 120 further comprises head members 130 secured to respective flange portions 128 of the web members, also by means of fasteners 18. Beam 120 differs from all of the previously described beams in that the triangular head structures are not folded from a single sheet of material, but rather are fabricated from individual elements, namely, intermediate portions 126 of web members 122 and head members 130.

These elements define a tubular structure with a generally triangular cross-section as in all other embodiments described thus far.

Beam 140 illustrated in Figure 12b is essentially identical to beam 120, but employs extended head members 142. Beam 150 shown in Figure 12c is again essentially identical to beam 120 but employs channel shaped head members 152. Figure 12d illustrates a beam 160 wherein head members 162 have a "C"-section. Figure 12e shows beam 170 in which head member 172 includes a longitudinal depression 173 that serves as a stiffening element. Head member 174 is shown as a simple plate identical to head members 130 of beam 120. However, it is to be understood that head member 174 could be identical to head member 172. In fact, any combination of head members can be utilized with the basic structure comprising web members 122 to accommodate special applications.

By virtue of flange elements 128 of the various embodiments illustrated in Figures 12a-12e, these beams are particularly well suited for fastening horizontal collateral elements, such as floors or ceilings, from either the top or bottom of each flange. By virtue of vertical flange elements 155, beams 150 and 160 are further adapted for fastening vertical collateral elements, such as partitions, wallboard, or window wall directly to the beam. Moreover, vertical flange elements 155 facilitate fastening beams 150 and 160 from the side to conventional strap hangers and the like. As in all of the previously described embodiments, the thickness of the individual members of these beams may be selected to achieve virtually any desired structural characteristics. The beams

illustrated in Figures 12a-12e offer the particular advantage of being more economical to manufacture, partly due to the fact that obtuse folds of material are not required.

It will be recognized that the above described invention may be embodied in other specific forms without departing from the spirit or essential characteristics of the disclosure. Numerous variations will be apparent to persons skilled in the art of structural design. For example, while the embodiments discussed above are most advantageously constructed of cold rolled sheet steel, a hot rolling process may be employed in certain applications. In particular, it should be noted that cold rolled and hot rolled sections may be combined as discussed above in connection with Figure 6. Furthermore, because of the open nature of the beams of the present invention, a plurality of such beams may be "nested" within one another to provide a greater load bearing capability than a single such beam without increasing the gauge of sheet material used.

To illustrate the advantages of the present invention, the following tables compare the calculated performance of a test section comprising the embodiment illustrated in Figures 2 and 3 with various standard structural shapes. In each of the following tables, the beam of the present invention has a height of 200 millimeters and a width of 60 millimeters. Results for three material thickness are presented, namely 1.0 millimeter, 1.2 millimeter, and 1.6 millimeter. All results are for standard sections of hot rolled British grade 43C steel, which is generally equivalent to ASTM A36.

In the following tables, Columns (a), (b), and (c) give the mass per meter, cross sectional area and moment of inertia for the sections respectively. Column (d) gives the load considered for deflection purposes, W_D, based on the design criterion that the maximum deflection should be less than 1/360th of a beam length of 3 meters. Column (e) gives the load ratio with respect to the test section. Column (f) gives the maximum span for each section when the point load equal to W_D for the test section is applied to the simply-supported beams. Column (g) gives the maximum span ratio with respect to the test section.

When a section of the present invention is compared with standard sections of similar mass per meter, its moment of inertia is significantly larger than that of the other sections. Thus, it supports more loading compared with the standard sections. Similarly, it spans longer than the standard sections for the same maximum deflection.

Table 1

	(a)	(b)	(c)	(d)	(e)	(f)	(g)
Section	Mass/Length (kg/m)	Cross-Sectional Area x 10^{-3} (m^2)	Moment of Inertia x 10^{-6} (m^4)	W_D (kN)	Maximum Load Ratio	Maximum Span (m)	Maximum Span Ratio
Test section 200 mm x 60 mm thickness = 1.0 mm	5.64	0.718	3.4670	10.790	1.0	3.000	1.0
Channel section 76 mm x 38 mm web thickness=5.1mm flange thickness=6.8mm	6.70	0.853	0.7414	2.310	0.21	1.387	0.46
Square hollow section 60 mm x 60 mm wall thickness = 3.2 mm	5.67	0.722	0.3870	1.204	0.11	1.002	0.33
Rectangular hollow section 80 mm x 40 mm wall thickness = 3.2mm	5.67	0.722	0.5810	1.810	0.17	1.228	0.41

Table 2

	(a)	(b)	(c)	(d)	(e)	(f)	(g)
Section	Mass/Length (kg/m)	Cross-Sectional Area x 10^{-3} (m^2)	Moment of Inertia x 10^{-6} (m^4)	W_D (kN)	Maximum Load Ratio	Maximum Span (m)	Maximum Span Ratio
Test section 200 mm x 60 mm thickness = 1.2 mm	6.764	0.8616	4.194	13.05	1.0	3.000	1.0
Channel section 76 mm x 38 mm web thickness=5.1mm flange thickness=6.8mm	6.700	0.853	0.7414	2.31	0.18	1.261	0.42
Square hollow section 60 mm x 60 mm wall thickness = 4.0 mm	6.97	0.888	0.4610	1.43	0.11	0.995	0.33
Rectangular hollow section 80 mm x 40 mm wall thickness = 4.0 mm	6.97	0.888	0.6960	2.17	0.17	1.222	0.41

Table 3

	(a)	(b)	(c)	(d)	(e)	(f)	(g)
Section	Mass/Length (kg/m)	Cross-Sectional Area x 10^{-3} (m^2)	Moment of Inertia x 10^{-6} (m^4)	W_D (kN)	Maximum Load Ratio	Maximum Span (m)	Maximum Span Ratio
Test section 200 mm x 60 mm thickness = 1.6 mm	9.02	1.1488	5.714	17.78	1.0	3.000	1.0
Channel section 102 mm x 51 mm web thickness= 6.1 mm flange thickness = 7.6 mm	10.42	1.3280	2.0770	6.46	0.36	1.809	0.60
Square hollow section 80 mm x 80 mm wall thickness = 3.6 mm	8.59	1.0900	1.0600	3.30	0.19	1.292	0.43
Rectangular hollow section 100 mm x 50 mm wall thickness = 4.0 mm	8.86	1.1300	1.4200	4.42	0.25	1.495	0.50
"I" section 254 mm x 102 mm web thickness = 5.8 mm flange thickness = 6.8 mm	22.0	2.8400	28.670	89.19	5.02	6.72	2.24
"Z" section 76.2 mm x 69.85 mm thickness = 6.35 mm	9.99	1.2710	1.195	3.72	0.21	1.37	0.46

CLAIMS

1. A fabricated structural beam comprising at least one longitudinally folded member having, in contiguous relationship, a first web portion, a folded head portion having first, second and third segments, and a second web portion fastened to said first web portion so that said head portion forms a three sided tube.

2. The fabricated structural beam of Claim 1 wherein said first, second and third head portion segments have substantially equal transverse dimensions such that the cross section of said head portion is a substantially equilateral triangle.

3. The fabricated structural beam of Claim 1 wherein said at least one longitudinally folded member is cold rolled from sheet steel.

4. The fabricated structural beam of Claim 1 comprising two longitudinally folded members substantially identical to each other and fastened together at their respective web portions.

5. The fabricated structural beam of Claim 4 wherein said web portion of each of said longitudinally folded members extends within said head portion of the other such member and terminates at a tail flange abutting said head portion of the other such member.

6. The fabricated structural beam of Claim 5 wherein each of said tail flanges is fastened to said head portion of said other folded member.

7. The fabricated structural beam of Claim 1 wherein at least one of said first, second and third head portion segments is embossed with a plurality of reinforcing ribs.

8. The fabricated structural beam of Claim 1 further comprising a longitudinal reinforcing member fastened to said first and second web portions.

9. A fabricated structural beam comprising:

a first longitudinally folded member having a web portion and a folded head portion having a triangular cross section, said head portion including a web flange extending substantially parallel to said web portion;

a second longitudinally folded member substantially identical to the first and interleaved therewith such that said web portion of each longitudinally folded member extends between said web portion and web flange of the other;

said first and second longitudinally folded members fastened to one another at their respective web flanges.

10. The fabricated structural beam of Claim 9 wherein each of said first and second longitudinally folded member is folded along an edge opposite said head portion to form a tail flange extending approximately perpendicular to said web portion.

11. The fabricated structural beam of Claim 10 wherein said tail flange of each longitudinally folded member abuts said head portion of the other longitudinally folded member.

12. The fabricated structural beam of Claim 11 wherein each of said tail flanges is fastened to said head portion of said other folded member.

13. The fabricated structural beam of Claim 11 wherein at least part of said web portion of each of said longitudinally folded members is corrugated.

14. The fabricated structural beam of Claim 13 wherein said corrugated part of said web portion of each of said longitudinally folded members is wholly disposed within said head portion of the other longitudinally folded member.

15. The fabricated structural beam of Claim 9 wherein at least one surface of said head portion of each of said longitudinally folded members is embossed with a plurality of reinforcing ribs.

16. A fabricated structural beam comprising:

a first longitudinally folded member having first and second web portions and a folded head portion having a triangular cross section;

a second longitudinally folded member substantially identical to the first and oriented with respect thereto such that their respective first web portions overlap;

said first and second longitudinally folded members fastened to one another at said overlapping first web portions.

17. The fabricated structural beam of Claim 16 further comprising a central longitudinal member inserted between said web portions of said first and second longitudinally folded members.

18. The fabricated structural beam of Claim 17 wherein said central longitudinal member is longitudinally folded along opposing edges to form substantially perpendicular flanges.

19. The fabricated structural beam of Claim 18 wherein said flanges of said central longitudinal member abut the head portion of said first and second longitudinally folded members respectively.

20. The fabricated structural beam of Claim 19 wherein said flanges of said central longitudinal member are fastened to said respective head portions.

21. The fabricated structural beam of Claim 17 wherein said central longitudinal member is a hot rolled steel section.

22. A fabricated structural beam comprising a longitudinally folded member having a pair of substantially parallel web portions fastened to one another, a folded head portion having a triangular cross section and a folded tail portion forming a pair of flanges extending from each of said web portions and substantially perpendicular thereto.

23. The fabricated structural beam of Claim 22 further comprising a central longitudinal member inserted between said web portions of said longitudinally folded member.

24. The fabricated structural beam of Claim 23 wherein said central longitudinal member is longitudinally folded along one edge thereof to form a substantially perpendicular flange.

25. The fabricated structural beam of Claim 24 wherein said flange of said central longitudinal member abuts the head portion of said longitudinally folded member.

26. The fabricated structural beam of Claim 25 wherein said flange of said central longitudinal member is fastened to said head portion of said longitudinally folded member.

27. The fabricated structural beam of Claim 23 wherein said central longitudinal member is a hot rolled steel section.

28. A fabricated structural beam comprising:

a first longitudinally folded head member having a generally triangular cross section with a base portion and a pair of angled portions extending from opposite sides of said base portion, said head member including a pair of web flanges extending from respective ones of said angled portions;

a second longitudinally folded head member substantially identical to the first;

a longitudinal web member inserted between said web flanges of each of said head members;

fastening means for securing said head members at said web flanges to said web member.

29. The fabricated structural beam of Claim 28 wherein said web member includes a pair of opposing flange portions abutting respective ones of said base portions of said head members.

30. The fabricated structural beam of Claim 29 wherein said flange portions are fastened to said respective base portions.

31. A fabricated structural beam comprising:

a pair of web members, each having a center portion, first and second outwardly angled intermediate potions and first and second flange potions contiguous with said respective intermediate portions, said center potions fastened to each other at their respective center portions;

a first head member fastened to said first flange portions of said web members so as to define a first tubular structure enclosed by said first head member and said first intermediate portions of said web members;

a second head member fastened to said second flange portions of said web members so as to define a second tubular structure enclosed by said second head member and said second intermediate potions of said web members.

32. The fabricated structural beam of Claim 31 wherein said web members are substantially identical.

33. The fabricated structural beam of Claim 31 wherein said web members and said head members are fastened by spot welding.

34. The fabricated structural beam of Claim 33 wherein said web members and said head members are fastened by mechanical fasteners.

35. The fabricated structural beam of Claim 31 wherein at least one of said head members is a flat plate.

36. The fabricated structural beam of Claim 35 wherein said at least one head member extends laterally beyond the respective flange portions of the web members.

37. The fabricated structural beam of Claim 31 wherein at least one of said head members has a channel section.

38. The fabricated structural beam of Claim 31 wherein at least one of said head members has a longitudinal indentation.

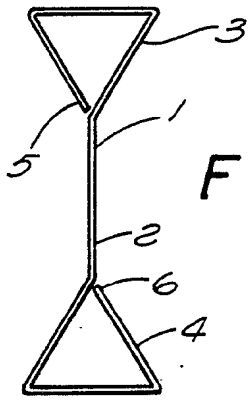


FIG. 1 PRIOR ART

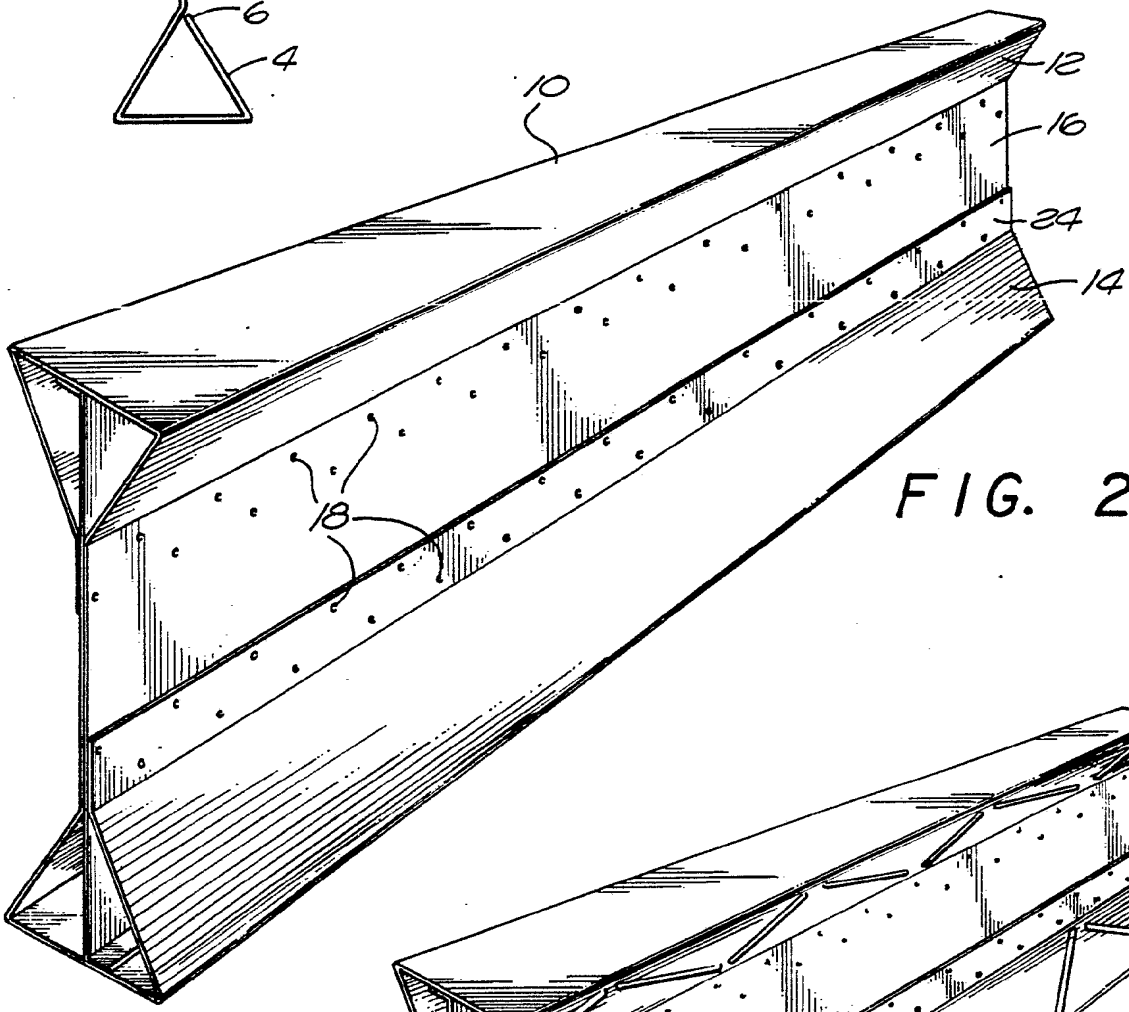


FIG. 2

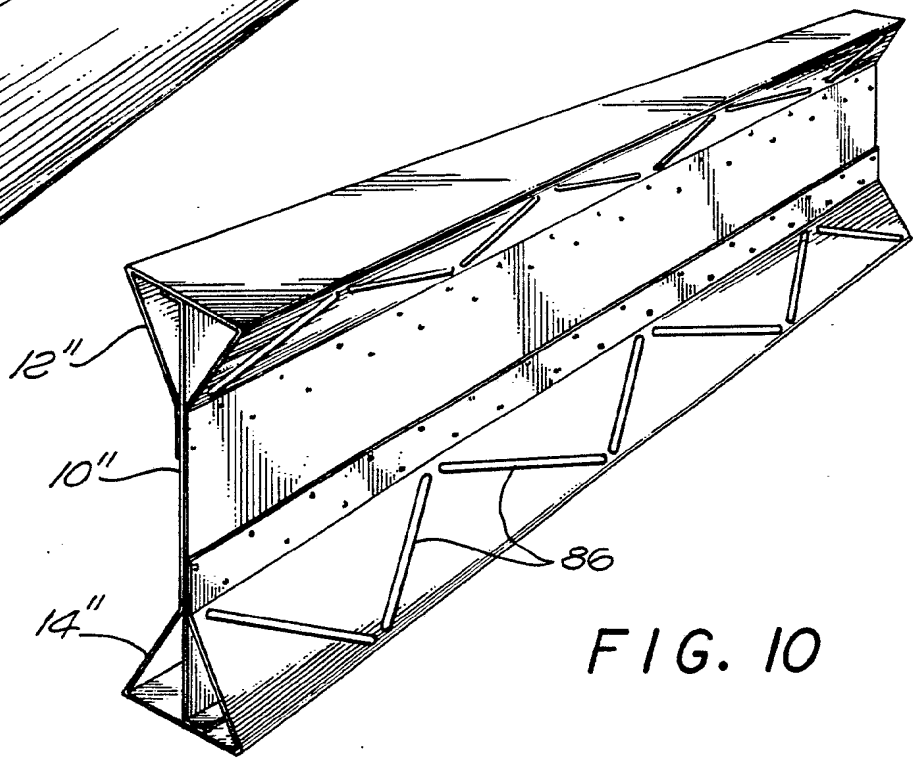


FIG. 10

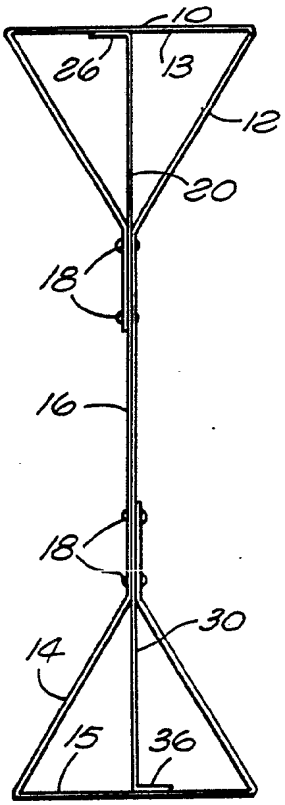


FIG. 3

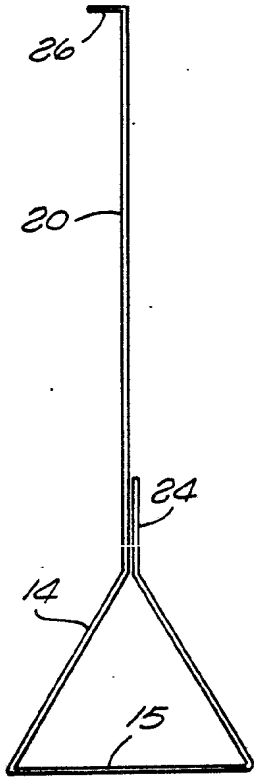


FIG. 4a

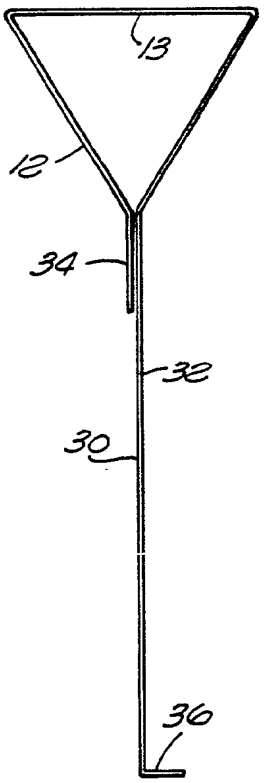


FIG. 4b

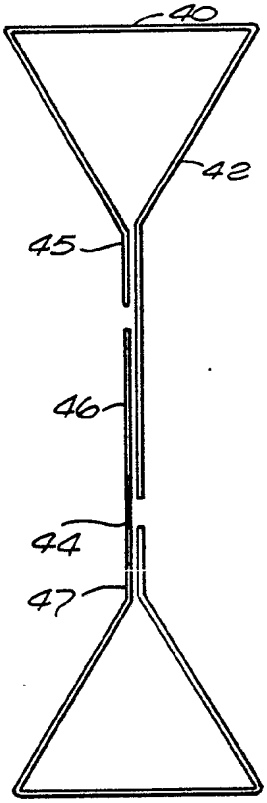


FIG. 5

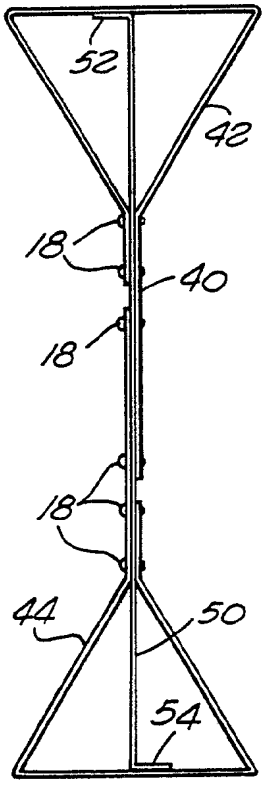


FIG. 6

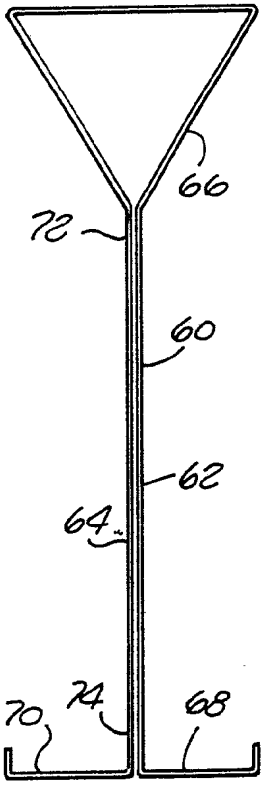


FIG. 7

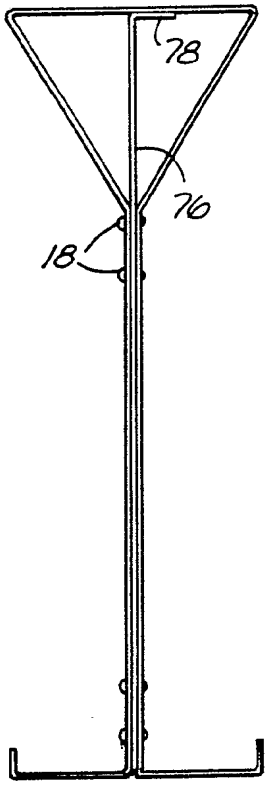


FIG. 8

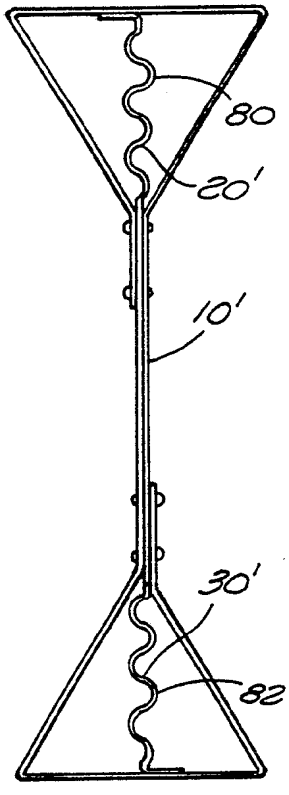


FIG. 9

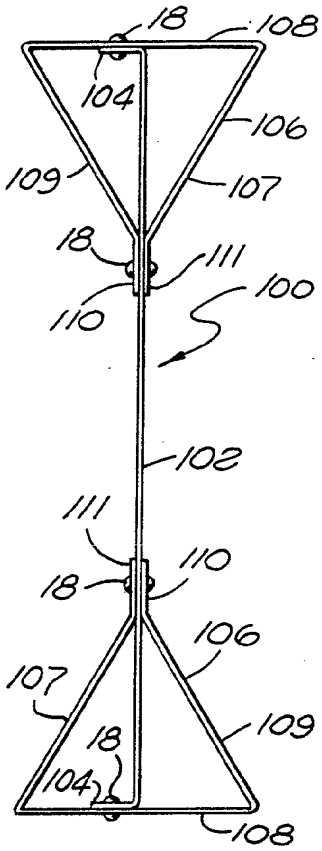


FIG. 11

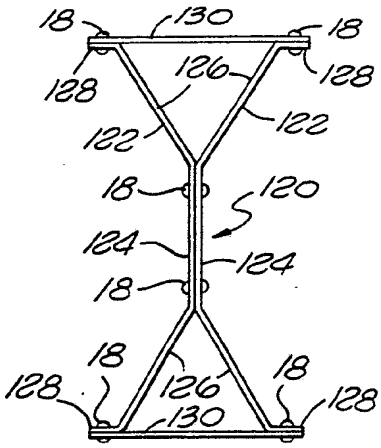


FIG. 12a

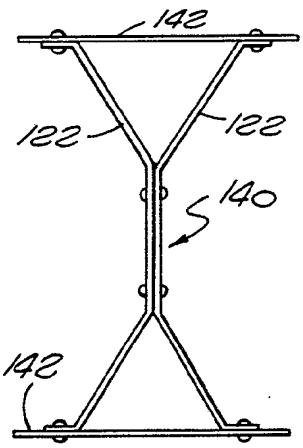


FIG. 12b

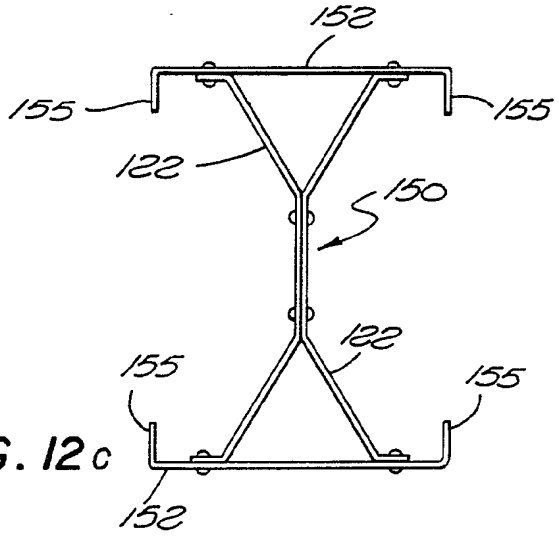


FIG. 12c

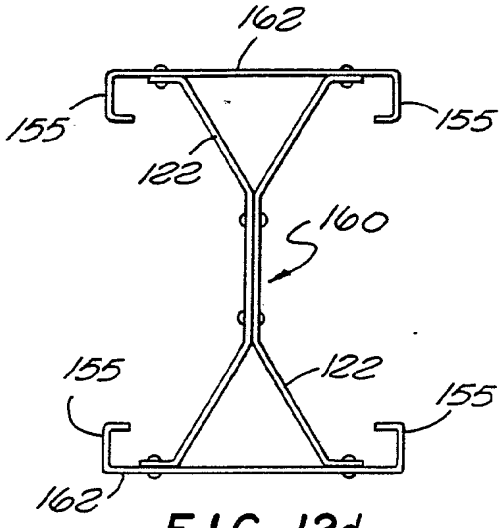


FIG. 12d

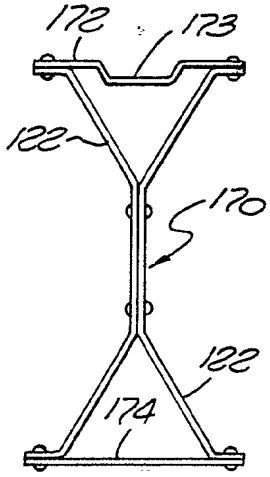


FIG. 12e

INTERNATIONAL SEARCH REPORT

International Application No. PCT/US91/02944

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC(5): E04C 3/30
US CL : 52/729,731

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
U.S.	52/729,730,731,732,720

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
X Y	DE, A, 494,796 (THIEMANN) 27 MARCH 1930. See the entire document.	1,3-8,31-38 2,9-30
Y	US, A, 991,603 (BROOKS) 09 MAY 1911. See the entire document.	2,9-30
A	US, A, 685,647 (SBORIGI) 29 OCTOBER 1901. See page 1, lines 98-104 and page 2, lines 1-6.	1-38
A	US, A, 2,605,867 (GOODWIN) 05 AUGUST 1952. See the entire document.	1-38
A	US, A, 3,256,670 (TERSIGNI) 21 JUNE 1966. See column 2, lines 8-14.	1-38

* Special categories of cited documents: [10]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
15 AUGUST 1991	13 SEP 1991
International Searching Authority	**Signature of Authorized Officer** [14]
ISA/US	NGUYEN NGOC HO INTERNATIONAL DIVISION RICHARD E. CHILCOT, JR.

Form PCT/ISA/210 (second sheet) (Rev.11-87)